Management and biology of pacific flyway geese

A symposium

R.L. Jarvis and J.C. Bartonek eds

Canadian Wildlife Service, Ottawa

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THE BRANT OF THE WESTERN QUEEN ELIZABETH ISLANDS, N.W.T.

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Abstract: The brant (Branta bernicla) breeding and moulting on Melville Island, Prince Patrick Island and the adjacent smaller islands pose some urgent problems to management agencies. The brant is one of the most successful species as a summer occupant of the vegetated coastal lowlands; but the very limited areas on eastern Melville Island suitable for brant have already been damaged by airstrip construction and other activities associated with oil and gas exploration and could be devastated by the prospective exploitation of gas and possibly oil offshore and the construction of a pipeline and related facilities on some of the sites most important to the geese.

Most of the brant concerned winter on the U.S. Pacific coast, chiefly in Puget Sound, Washington. There too their haunts are threatened with destruction, by gravel extraction and by marine oil transport. Intensive hunting also threatens these geese, which now bear the brunt of winter hunting in the vicinity of Padilla Bay and Samish Island.

The breeding brant of Melville Island are mostly paler on the belly than the brant breeding in Alaska and on Banks Island. They tend to be darker than those wintering on the U.S. Atlantic coast, which breed to the south and east, chiefly around Foxe Basin, and than the brant of the eastern Queen Elizabeth Islands, which winter in Ireland and which seem to be spreading westwards. The brant of Melville and Prince Patrick islands mostly have tall white necklaces, like those breeding in Alaska but larger than those of brant breeding elsewhere in Canada. They should be treated as a distinct stock, of well under 10,000 individuals, and be given special protection. Non-breeding moult-immigrants captured included some very dark birds, only one of which has been recovered, in Kamchatka, USSR.

The western Queen Elizabeth Islands provide a microcosm for the study of intra-specific competition in a severely limited environment. As much as possible of the vegetated lowland habitat used by the brant and by most of the other birds frequenting the islands should be preserved from man-made damage.

An experimental Biophysical Inventory and Reconnaissance Mapping Program on eastern Melville Island was carried out in the summers of 1973-

1975 by a team drawn from the Geological Survey of Canada and the Canadian Wildlife Service (Barnett 1976, Barnett et al. 1975, Barnett et al. 1977). One of us (Maltby) was responsible for the ornithological contribution to that integrated survey. In the course of the work it became clear that brant (Branta bernicla) were some of the most abundant birds in the vegetated lowlands. It had been known since 1948 that the brant on the neighbouring Prince Patrick Island were of special interest because they included both light-bellied and dark-bellied individuals, regarded by Handley (1950) as representing two species - B. bernicla hrota and B. nigricans respectively - although MacDonald (1954) and Manning et al. (1956) preferred to consider them as intergrades. We took advantage of Maltby's membership of the survey team and of the availability of a helicopter to extend the search for brant beyond the Mapping Program area and to capture as many moulting brant as possible, in order to record their appearance and to make them with standard leg bands and also, in 1974 and 1975, with highly-visible neck collars.

The results to be described below suggest that at least three stocks of brant use the western Queen Elizabeth Islands, or Parry Islands, to breed or to moult, and that the indigenous stock is very small. That is inevitable because, as we describe, only a small fraction of the area of the islands provides suitable feeding areas for brant. Some of those areas have already been destroyed by recent human activities and further losses of habitat are threatened if the extraction of oil and gas becomes commercially attractive. We pose several questions to those agencies responsible for waterfowl management in North America and provide some of the information needed to answer them, while recognising that the value judgments involved are not limited to consideration of biological facts. How many geese, of how many kinds, in how many places, do you want, and at what costs to whom? These kinds of questions are perhaps easier to bring into focus when looking at remote areas in the high arctic desert than when looking at the crowded shorelines of California, although one of the points we seek to make is that human actions in places far removed from the Parry Islands may be decisive in determining the future of the geese that struggle to maintain themselves in that desolate place.

METHODS

Distribution of geese

Surveys in Nesting Period

In order to determine the distribution and abundance of all species of birds on the Reconnaissance Mapping Program study area on northeastern Melville Island, a mixture of aerial surveys and ground searches was used. For finding brant, the aerial surveys were the more important. Observations were made from a Bell Jet Ranger 206B helicopter in 1973 and 1974 and from a Hughes 500 C in 1975, flown 30 m above the ground at a standard speed of 160 km/h, reduced when necessary for the better identification of birds seen. The effective strip width for geese was about 1 km. There were three observers, one in the offside front seat and two in the rear seats, in radio communication so that all the birds seen could be plotted immediately by the recorder. Maps based on vertical aerial photograph of scale 1:60000 were used, in 1974 and 1975 with predetermined boundaries of habitat types using the classification developed in 1973 by the Integrated Landscape Survey project. The aerial surveys during the nesting period were designed

to provide information about the use of different habitat types by all kinds of birds. They were not intended to provide a census of brant, though they did indicate relative abundance.

Ground searches, on foot or using Honda tricycles with balloon tires, which were used chiefly for the detection of small birds not readily seen from a helicopter, provided a few incidental records of nesting brant. More intensive study of nesting brant was planned for June 1974: but delayed snow clearance that year prevented the geese and many other birds from attempting to nest and also greatly restricted movement on the ground until well into July.

Surveys and Banding in Moulting Period

From mid-July helicopter searches were used to find the whereabouts of flocks of moulting geese. Banding of flightless geese was carried out from 14 July to 16 August 1973, 14 July to 4 August 1974 and 17 to 27 July 1975. The techniques to capture, by using the helicopter to herd the geese into netting cages, and the construction and application of the neck collars are described by Maltby (1977).

Except when bad weather or other constraints limited activities to determining the age and sex of the geese caught and fitting leg bands and neck collars, the birds were also weighed and standard measurements of the exposed culmen and tarsus were made. The morphometric data will not be used here, because they confirmed that the brant of the Queen Elizabeth Islands were indistinguishable by size from those elsewhere in the breeding range. However, up to four features of the plumage were recorded.

In all three years, estimates of the belly and thigh colour were made by comparing the colour of the main body of the feathers with those of standard chips included in the Munsell Soil Color Chart (Munsell Color Company, Baltimore, Maryland, 1971). Munsell charts assign 3 dimensions to a colour: hue, value and chroma. The hue notation of a colour indicates its relation to the sequence red, yellow, green, blue and purple; the value its lightness; and the chroma its strength (or departure from a neutral of the same lightness). Each chart displays a graded series of standard colour chips arranged in rows and columns with circular apertures between each row, so that the sample to be matched can be compared directly with a succession of standards until the best fit is obtained. A perfect match is not often encountered but it is usually not very difficult to decide on the closest match. The blacks, browns and greys that were found on brant feathers were best encompassed by the hue chart 10 YR, with colour values ranging from 2.5 to 7 (mostly 4-6) on the 8-point scale and chroma 1 or 2 (infrequently 3). Though the matching process remains a subjective one, good agreement between different observers was obtained and for nearly all the field sampling a single observer made all the judgments. The same person (L.S.M.) also dealt with material in the National Museum, Ottawa while training H.B. who examined material in other museums.

In the field and in the earlier museum studies the colour value recorded was that of the nearest matching chip. In later museum work, following the makers' instructions to users of the chart, we used interpolated values, estimated to 0.1. This was primarily to check on the effects of 'lumping' on the estimation of mean colour values for samples from different localities.

Belly colour was determined from the feathers in the mid-line 2-3 cm behind the usually sharp transverse line of demarcation between the black feathers of the neck and the paler ones of the belly. The feather tract used to indicate thigh colour was close to the insertion of the thigh on the body, in an area little exposed to direct sunlight. It proved somewhat awkward to standardise the site selected and this indicator was temporarily abandoned in 1974. Further work has shown that the ratio of thigh colour to belly colour seems to vary between stocks and over time within a stock. However, it seems also to vary with individual age. Because of these complexities, we do not use thigh colour as a discriminant here, though it may eventually prove more useful than belly colour.

Brant have a white 'necklace', formed by the local absence of black tips to the basically white feathers over more or less extensive areas (Alpheraky 1905). We measured the greatest height of this white marking and also the extent to which it appeared to encircle the neck (on an arbitrary scale in which '2' signified complete encircling, '1½' incomplete back or front, '1' broken front and back, '½' very incomplete and '0' wholly absent (the latter in birds of the year only). No data on necklace size were collected in 1973, nor in some later catches, when it was necessary to be as speedy as possible in handling the geese.

Measurements of Museum Skins

To obtain comparative material from other parts of the range we sought out skins of brant in several large collections: American Museum of Natural History, New York; National Museum of Canada, Ottawa; British Museum (Natural History), Tring; Zoological Museum, Copenhagen; Museum of the California Academy of Sciences, San Francisco; Los Angeles County Museum of Natural History; Smithsonian Institution, Washington, D.C.; National Museum of Ireland, Dublin. We made as many measurements as possible. In many cases the necks of the specimens had been distorted so that necklace height could not be obtained. Less often, the appropriate feather tract on the thigh was inaccessible. The colour matching was done in direct daylight, except in San Francisco where artificial lighting said to be nearly equivalent was used.

RESULTS

Summer Distribution of Brant

The observed distribution of brant on Melville Island, Prince Patrick Island and Eglinton Island in 1973 and 1975 and in eastern Melville Island in 1975 is mapped in Figure 1. The restricted search in 1975 was due to lack of funds. 'Breeding brant' were those in flocks including some goslings; the numbers of successful breeders could not be reliably established.

There are noticeable differences, as well as resemblances, in the scatter of flocks around the coast in the three years. Perhaps the most striking is the concentration of brant in relatively few sites in 1974. In that summer, when no goslings were seen, twice as many moulting adults were present on eastern Melville Island in late July as there had been in 1973. The average flock size on all three islands was much greater in 1974 than in 1973. In 1975 the flock sizes and distribution on eastern Melville Island were similar to those in 1973.

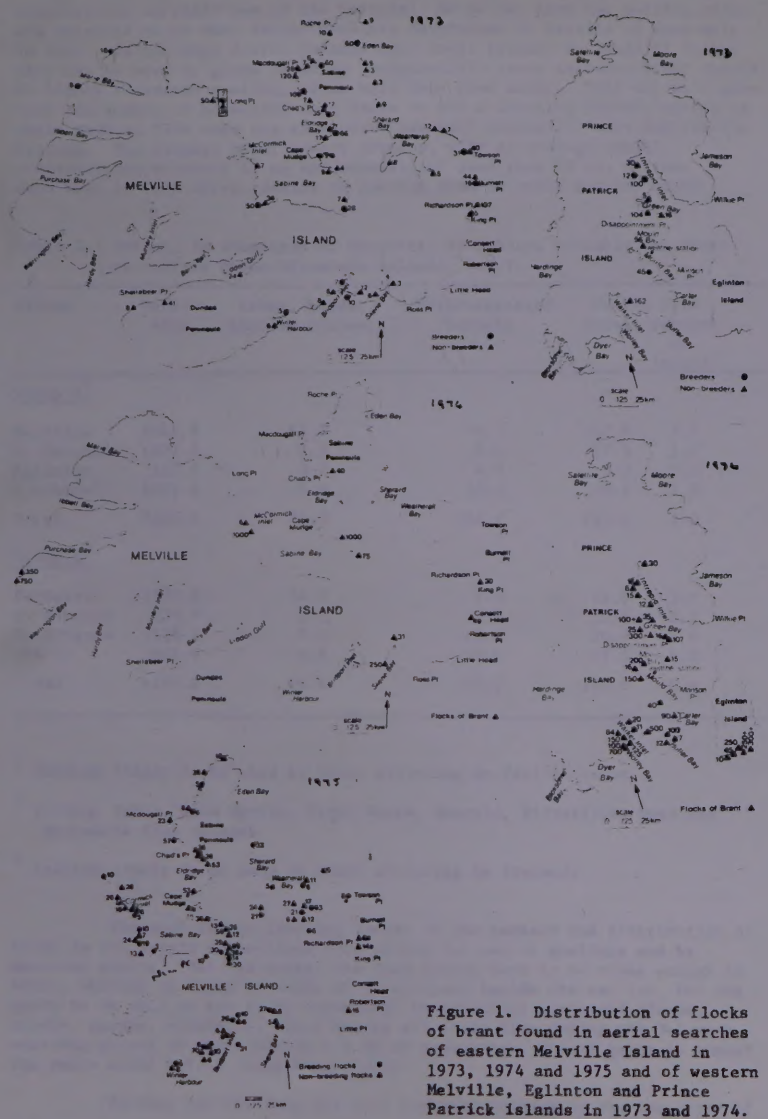

Figure 1. Distribution of flocks of brant found in aerial searches of eastern Melville Island in 1973, 1974 and 1975 and of western Melville, Eglinton and Prince Patrick islands in 1973 and 1974.

Table 1. Summary of number of flocks (in parentheses) and of individual adult brant found in aerial searches of eastern Melville Island in 1973, 1974 and 1975 and of western Melville, Eglinton and Prince Patrick islands in 1973 and 1974. Mean flock sizes underlined; - indicates no search.

	1973	1974	1975
Eastern Melville I.			
- with young	(15) 531 35.4	0	(31) 583 18.8
- without young	(35) 682 19.5	(9) 2471 274.6	(41) 874 21.3
total	(50) 1213 24.3		(72) 1457 17.8
Eglinton I.			
- without young	0	(5) 855 171.0	-
P. Patrick I.			
- with young	(3) 157 52.3	0	-
- without young	(6) 373 62.1	(28) 2592 103.3	-
total	(9) 530 58.9		
Area Total	3400	5900	

Habitat Types used by Brant

The pilot mapping project on Melville Island led to a three-level classificatory hierarchy of Landscape Type (regional), Geobotanical Facies (intermediate) and Terrain Units (local), as outlined by Barnett et al. (1975). Each sedimentary bedrock formation has a distinctive morphological development with associated suites of landforms and vegetation. Such a system leads to quite a complicated matrix of attributes: 21 Terrain and Landscape Units were described for the surveyed area. Brant were seen on 15 of those units but 51 percent of the records referred to brant on lakes and tundra ponds. Another 39.5 percent were reported from (relatively) well-vegetated areas on Alluvial Terraces, on Discontinuous Marine Veneers or on Coastal Lowlands, the remainder being scattered meagrely across poorly vegetated units. All were on terrain below the marine limit (BML), (which reaches as high as 110 m a.s.l. at Towson Point on the east coast of Melville Island), where marine processes have reworked the surface materials. Thus, though much more study would be necessary to determine in detail what amounts of vegetation are available to and used by the brant of the Queen Elizabeth Islands, it is possible to use a very crude classification to identify the extent of the habitat that the geese may be able to use, regularly or intermittently, as has been done by D.J. Fairbairn (1978, A Regional Investigation of Migratory Bird Use and Habitats in the Western Sverdrup and Parry Islands, Contract Report, CWS Western and Northern Region, Yellowknife, N.W.T.). Fairbairn based his investigations on the interpretation of vertical aerial photographs. He obtained a reasonably good fit between his classification and that of Barnett et al. (loc. cit.) on eastern Melville Island. In Table 2 we have regrouped Fairbairn's data to provide estimates of the extent of suitable water bodies and vegetation on the islands.

Two major points emerge from this analysis: (1) the areas likely to be used by brant form only a tiny fraction of the total area of the islands and (2) Melville Island provides nearly three-quarters of the potential habitat in the western group of islands. On the first point it is worth

noting that the behavioural requirements of the geese impose considerable restrictions on their use of the terrain. We do not know how nesting sites are selected or to what extent they are determined by details of snow-melt in June. As the High Arctic islands lack small islands in lakes or deltas that can be used by geese breeding "colonially", these northern brant resort to highly dispersed nesting, often well away from water. This may well mean that the supply of potential nest istes is not a limiting factor, except in years such as 1974 when the snow cover was both unusually heavy and late in melting. The climate is of desert dryness, with an average annual precipitation of about 12 cm and snowfall of less than 60 cm, so that snow melt is less often crucial to nesting than in areas further south.

Table 2. Extent, in thousands of hectares, of habitat suitable for brant on western Queen Elizabeth Islands, N.W.T.

Island	Total Area	Lakes, ponds, braided channels	Well-vegetated Terrain	Usable Area Total	Usable Area Percent of Island
Group A[1]					
Melville	5041.9	43.2	74.7	117.9	2.3
P. Patrick	1872.8	8.3	9.6	17.9	1.0
Eglinton	162.6	0.7	4.6	5.3	3.3
7 others[2]	1038.8	4.4	15.8	20.2	1.9
Total	8116.1	56.5	104.7	161.3	2.0
Group B[3]					
Bathurst	1829.8	54.3	7.8	62.0	3.1
A. Ringnes	529.9	1.1	9.8	10.9	2.1
E. Ringnes	1128.4	2.3	18.2	20.4	1.8
others	801.9	6.9	20.4	27.3	1.5
Total	4290.0	64.6	56.2	120.6	2.8

[1] Islands likely to be used by brant wintering on Pacific coast.

[2] Borden, Brock, Byam Martin, Eight Bears, Emerald, Fitzwilliam Owen and Mackenzie King islands.

[3] Islands likely to be used by brant wintering in Ireland.

The most likely limiting factor on the numbers and distribution of brant is the supply of suitable food plants for use by goslings and by moulting adults. For the latter the food plants have to be close enough to water, whether in lakes or ponds or shore-leads inside the sea ice, for the geese to be able to run to if threatened by potential predators (foxes, wolves, people, aircraft). Thus nearly all their time during the 3-4 week moulting period is spent within 0.5 km of open water, though later in August the geese could safely range more widely.

Further restrictions are very probably imposed by the low rates of

plant growth and very short growing seasons characteristic of the high arctic islands. The available supplies are also used by the large resident herbivores, Peary caribou (Rangifer tarandus pearyi) and muskoxen (Ovibus moschatus). Without detailed studies it is impossible to determine what factors limit the food resources available to brant in July and August. But we suggest the possibility that some of the observed variations in the distribution of brant in different years may reflect the insufficiency of the vegetation at some sites to permit its exploitation by brant every year. If it is indeed necessary for the herbivores to follow a strategy of intermittent or rotational grazing, it cannot safely be assumed that an area not seen to be exploited in any particular year is either of no importance to brant or constitutes an untapped source that might permit the islands to hold larger numbers of brant than were seen there in 1973-1975.

Results of Marking Brant

Marking effort

In 1973, 11 catches of brant were made on Melville Island, 3 on Prince Patrick Island and 1 on Bathurst Island, leading to the banding of 385, 271 and 44 brant respectively. In 1974, 5 catches on Bathurst Island resulted in the release of 277 newly-banded geese (174 with neck collars); 4 catches on Prince Patrick Island and 1 on Eglinton Island yielded 75 newly-marked geese (48 wich neck collars); and 2 catches on Axel Heiberg Island yielded 87 (74 neck collars). In 1975 banding was confined to eastern Melville Island - 14 catches, 505 newly-marked geese, 335 neck collars - together with a catch of 29 brant on Bathurst Island (28 collars). The 1973 and 1975 catches on Melville Island included 93 and 41 'locals' (goslings old enough to hold leg bands but not yet able to fly); and the 1973 catch on Bathurst Island included 38 locals. Amongst the yearlings caught in 1973 and 1974 there was a marked excess of females (34 males:60 females) on Melville Island in 1974 though otherwise the proportions were nearly equal. Only 4 yearlings were caught in 1975, which was not surprising in view of the lack of local breeding in 1974. Amongst the brant more than 1 year old there was an excess of males (593:521 in all).

Recoveries and sighting of marked brant

A detailed analysis of the recoveries and sightings of the marked brant will be published elsewhere (L.S. Maltby, in preparation). Here we summarize the results very briefly in Table 3. This shows how much additional information has been provided by sightings of neck-collared geese, particularly in Iceland and Ireland, where shooting of brant is prohibited, and how high the recovery rate has been. The chief point of concern here, though, is the striking evidence of a massive dichotomy in the winter destinations of the brant frequenting the Queen Elizabeth Islands. As indicated by Maltby-Prevett, Boyd and Heyland (1975), brant from the eastern part of the archipelago winter in Ireland and France, staging in Iceland in both fall and spring. Apparently the brant from Bathurst Island and some from eastern Melville Island also go to Ireland but the majority of those from Melville and Prince Patrick islands evidently head to the Pacific coast.

Table 4 shows that nearly all of the Parry Islands brant shot on the Pacific coast have been taken in Puget Sound, Washington, where most of them spend the winter (Table 5). Only a few move on through California to

Mexico, as do the great majority of the brant coming from Alaska and many of those marked on the Mackenzie coast, N.W.T. For many reasons, above all the facts that few brant were being banded in Alaska in 1973-1975 and that there are few reports from Mexico where most of the Pacific brant now winter, it is impracticable to make detailed inferences from the recoveries about the relative abundance of brant from different breeding areas in wintering and staging areas. Of potential importance for the welfare of the Parry Island brant are the indications from Table 5 that an increasing proportion of the kill is being taken in February; or, alternatively, that the kill early in the winter has fallen off. In marked contrast to the data in Table 5, brant banded in Alaska and the Mackenzie District and subsequently shot in Puget Sound in 1974-75 to 1977-78 show no change in the proportion shot in February to those shot in November-January.

Table 3. Summary of marking of brant on Parry Islands, 1973-1975 and on Axel Heiberg I., 1974, and of recoveries and sightings (in parentheses) reported to May, 1977.

Where Banded Year	No. Banded	Neck Collars	Recoveries and Sightings: Wash-ington	Other Pacific[1]	Ireland	Other Atlantic[2]	Total Reported
Melville							
1973	385	-	33	-	1	-	34
1974	277	174	44(1)	7(1)	-(3)	1(3)	52(8)
1975	505	335	71(58)	2(7)	-(13)	-(2)	73(80)
P. Patrick, Eglinton							
1973	271	-	10	2	-	-	12
1974	75	48	18	1	-	-	19
Bathurst							
1973	44	-	-	-	1	-	1
1975	29	28	-	-	-(19)	-(1)	-(20)
A. Heiberg							
1974	87	74	-	-	3(7)	-(24)	3(31)

[1] (Other Pacific) 7 recoveries and 7 sightings of Melville I. brant in California, 1 sighting in British Columbia and 2 recoveries in Mexico; 2 recoveries of Prince Patrick I. brant in California and 1 in Kamchatka, U.S.S.R.

[2] (Other Atlantic) 1 from Melville I. recovered in France and 1 seen there; another sighted both in England and in the Netherlands; 2 seen in Iceland. 1 from Axel Heiberg I. seen in Greenland and 23 seen in Iceland. 1 from Bathurst I. seen in Iceland.

Table 4. Recoveries along the Pacific coast in November-February of winters 1973-74 to 1977-78 of brant marked on Parry Islands compared with those of brant marked in Mackenzie District, N.W.T. and Alaska.

Found	Marked	Recovered: Nov.	Dec.	Jan.	Feb.	Winter
Puget Sound						
	Parry Is.	14	76	33	26	149
	Mackenzie	1	6	6	18	31
	Alaska	1	6	7	4	18
Total		16	88	46	48	198
Other U.S., Mexico						
	Parry Is.	-	1	4	4	9
	Mackenzie	-	2	9	13	24
	Alaska	3	6	18	50	77
Total		3	9	31	67	110

Table 5. Recoveries in Puget Sound, Washington in seasons 1974-75 to 1977-78 of brant marked on Parry Islands.

Season	Recovered: Nov.	Dec.	Jan.	Feb.	Total
1974-75	6	28	7	4	55
1975-76	4	30	21	5	60
1976-77	3	6	4	10	23
1977-78	1	1	1	7	10
Total	14	75	33	26	148

Another point of management interest is that only 1 Parry Island brant has so far been reported in British Columbia, where 32 Alaskan-banded and 4 Mackenzie-banded brant were recovered in September in 1973-1977, 4 in December, 4 in January and another in February. Very few brant now winter in British Columbia. It may be fortunate that the geese from the Parry Islands do not attempt to do so.

The lack of recoveries of Parry Islands brant from British Columbia helps to emphasize the scarcity of knowledge of the migration routes they follow to and from Puget Sound. A sighting of a collared brant, not individually identified and so not listed in Table 3, at the major brant concentration area in Izembek Bay, Alaska, in November 1974, is consistent with the "traditional" view (as described, e.g. by Bellrose, 1976) that the brant of northwestern Canada travel to the Pacific coast by way of western Alaska, an extraordinarily devious route. The record from Kamchatka in late May 1974, however, suggests that the geese moulting in the Parry Islands may include moult-migrants from much further west, which might well not follow the same route in autumn as the geese breeding in the Parry Islands.

The absence of any recoveries or sightings from eastern Canada and the U.S. Atlantic coast, where some of the major wintering flocks are looked at intensively, suggests that the brant moulting in the north-western islands do not usually include members of the Atlantic coast stock, the breeding

stronghold of which lies around Foxe Basin and at the eastern end of Queen Maud Gulf.

Appearance of Parry Islands Brant

Alternative hypotheses

The demonstration that the brant of the Parry Islands and those summering further east winter in areas as remote from each other as Washington and Ireland helps to suggest ways in which the information on the belly- and thigh-colour of the brant and on the appearance of the necklace may be assembled and tested. Was Handley (1950) correct in identifying two distinct stocks on Prince Patrick Island in 1948 and 1949? Are the indigenous geese of the Parry Islands distinguishable from those breeding elsewhere in Canada, or in other parts of the circumpolar range of the brant? Can the colouring of the captured geese be used to separate moult-immigrants, if any, from locally-breeding birds?

Table 6, summarizing the information on the belly-colour at capture of brant subsequently taken or seen elsewhere, shows that the geese going to the Pacific coast tended to be darker-bellied than those going east across the Atlantic; and that of those going to the Pacific coast the birds that went furthest south were amongst the darkest. Even when such a crude classification of colour is used the larger samples show a substantial range of values and there is no gap between the colour of one group and the other. This is consistent with the findings of Manning et al. (1956) who examined 15 brant from Prince Patrick Island in the National Museum of Canada, collected by MacDonald (1954): "A selection of six of these birds, when laid out according to the colour of the lower breast, form a well-graded series from extreme pale B. b. hrota to moderately dark B. b. nigricans. The only grades missing were moderately dark B. b. hrota (grade 2) and an extremely dark B. b. nigricans grade 8. These gaps were filled by a specimen from eastern Canada and a dark bird from Banks Island." They used the series as a standard for the comparison of other species in the museum, finding skins from eastern arctic Canada and Greenland to be chiefly hrota with a few "intergrades" and those from Alaska and Banks Island to be chiefly nigricans, with a higher proportion of intergrades. They note that 2 specimens taken on Melville Island by the Bernier expedition (in 1909) are "a typical Black Brant (June 27) and the other a typical American Brant (July 6); and consider that "at least five, possibly seven, of the 15 Prince Patrick Island specimens are intergrades. This is completely at variance with Handley (1950) who states that of 13 adults he collected on Prince Patrick Island in 1949, nine were nigricans and four hrota."

Table 6. Belly colours of brant banded on the Queen Elizabeth Islands, 1973-1975 and recovered or sighted elsewhere, 1973-1977.

Found	Belly Colour 2.5	3	4	5	6	7	N	Mean Score
Kamchatka	1	-	-	-	-	-	1	
Washington	-	20	63	63	7	-	153	4.4
Cal.-Mexico	-	13	-	-	-	-	13	3
Iceland	-	-	4	11	7	2[1]	24	5.3
Ireland	-	2	5	24[2]	3	2	36	4.9

[1] incl. 1 Greenland; [2] incl. 2 from France, 1 England/Netherlands

Manning et al. (loc. cit.) discuss the situation in terms both of taxonomy - what subspecific names should be applied to what individuals? - and of genetic mechanisms - how could mixed pairings occur and how would their offspring look? We adopt a different approach. It seems unprofitable to use the concept of subspecies and we have no information on pair formation amongst Parry Islands birds and very little on their appearance over time. Accordingly all we seek to do is to record the variability in belly-colour and in necklace-size that we found in the geese handled in 1973-1975 and then compare these findings with the appearance of brant taken elsewhere in the Arctic.

The island-by-island summary of belly-colours in Table 7 is consistent with the expectations derived from Tables 3 and 6. The brant taken on the more easterly islands are paler than those in the west. On Melville and Prince Patrick islands the 1973 catches were remarkable for the relatively large numbers of birds classed as 2.5 (very dark brown), few of which were taken in 1974 and 1975; pale geese were more frequent in 1975 than earlier. On both those islands the modal colour was 4 (dark gray), while on Bathurst and Axel Heiberg islands it was 5 (gray), with many lighter birds on Axel Heiberg but almost as many darker ones on Bathurst.

Table 7. Belly colours of brant captured in moult on the Queen Elizabeth Islands, 1973-1975.

Where, year	Belly Colour 2.5	3	4	5	6	7	N	Mean Score
Melville I.								
1973	14	45	85	18	1	-	163	3.7
1974	1	55	65	68	26	-	225	4.1
1975	5	87	120	104	6	-	322	4.0
P. Patrick I.								
1973	37	27	111	32	4	-	211	3.8
1974*	1	28	29	13	-	2	83	3.8
Bathurst I.	-	2	18	21	1	-	42	4.4
Axel Heiberg I.	-	1	2	56	30	4	93	5.4

*incl. 10 Eglinton I.

Examining the recovery-rates of geese with different belly-colours, the discrepancy that seems most likely to be of biological significance is that the 58 very dark birds (colour 2.5) marked on Prince Patrick and Melville islands in 1973 have yielded only 1 recovery, that in Kamchatka, USSR. They were perhaps moult-migrants, which did not return to the Parry Islands in 1974 or 1975 and which did not winter on the U.S. Pacific coast.

Tables 8 and 9 summarize the information on the conformation and height of the white necklaces, which tend to be taller in males than in females. On Melville Island and among the paler brant further east the necklaces were most often broken at back and front. On Prince Patrick and Eglinton islands the majority were broken at the back only. Necklaces occasionally exceeded 50 mm in height but most were in the range 21-35 mm, without clear difference between the groups taken on different islands.

Table 8. Completeness of white necklace on moulting adult brant captured in the Queen Elizabeth Islands, 1974 and 1975. Sexes combined, as no significant differences between them.

Island		score	Broken back and front (½)1	Broken at back 1½	Complete 2	Total
Melville	1974		83	49	11	143
	1975		175	105	20	300
P. Patrick	1974		19	30	4	53
Eglinton	1974		4	6	-	10
Axel Heiberg	1974		52	6	1	59
Total			333	196	36	565

Table 9. Height of white necklace, (in mm), on adult Brant captured in the Queen Elizabeth Islands in 1974 and 1975.

Island	Trace	1-20	21-25	26-30	31-35	36-55	Total sample	Mean height
Females								
Melville	6	24	28	26	23	18	125	26.6
A. Heiberg	-	19	13	13	4	-	49	23.2
P. Patrick	-	4	10	9	-	9	32	25.5
Eglinton	-	2	2	1	-	-	5	22.6
Total	6	49	53	49	27	27	211	25.6
Males								
Melville	3	4	8	24	25	32	96	32.0
A. Heiberg	-	5	12	11	7	4	39	27.2
P. Patrick	-	3	3	10	9	15	40	34.0
Eglinton	-	1	1	1	2	-	5	27.0
Total	3	13	14	46	43	51	150	31.3

To relate the appearance of the brant of the Parry Islands to those found elsewhere in the Arctic in summer we resort here to 2 diagrams (Figures 2 and 3). The diagrams plot the mean scores on 2 characters for each group from a different part of the breeding range, together with an ellipse enclosing the area (±1.96 s.d.) within which the true mean value for the same population is most likely to lie. These limits are based on the over-simplified assumption that necklace characteristics and belly-colour are independent. The sizes of the ellipses are much affected by the sizes of the available sample. A fuller account of this material is being prepared; here we are concerned chiefly to show that the brant from Melville and Prince Patrick islands are, as Manning et al. (1956) first showed, intermediate in appearance between the dark brant of Alaska, northwest Mackenzie District and Banks Island and the pale brant of eastern Canada, Greenland and Spitsbergen, being as distinguishable by their incomplete, rather tall necklaces as by their rather dark colour. Because it would be impracticable to differentiate many of the individuals occurring on the Parry Islands from similar looking birds from elsewhere in the range, there seems no point in seeking to define the "Parry Islands brant" in taxonomic terms. Yet the evidence from recoveries of their concentration in winter in Puget Sound suggests strongly that there exists a relatively distinct and homogeneous local group, in addition to the "Black brant" and "Atlantic brant".

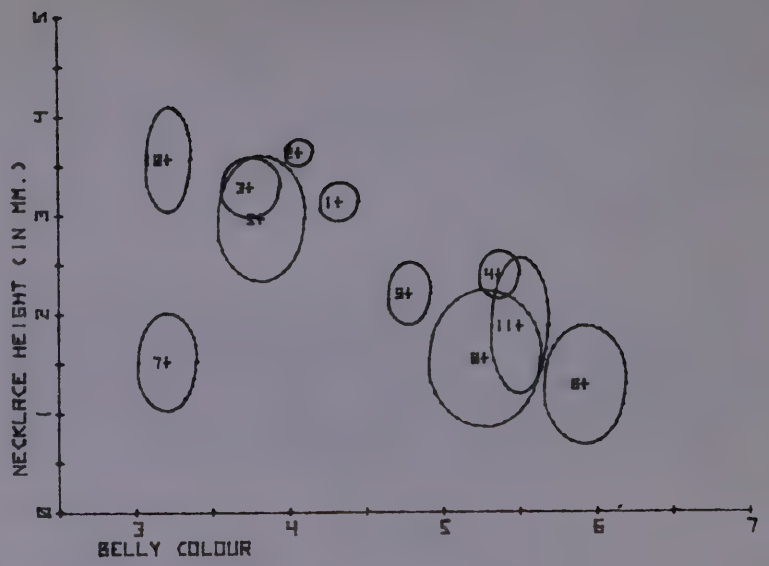

Figure 2.

Mean belly colour values of samples of brant drawn from different parts of the breeding range related to sample means of necklace height. 95% probability that the true population mean would fall within the ellipse around the plotted point. The numbers alongside the means identify the samples according to the key that follows. The numbers in parentheses (x, y) following each name indicate sizes of samples used to derive means, where x = sample for necklace height, y = sample for completeness of necklace.
Key: 1 - Melville I., 1974 (221, 143); 2 - Melville I., 1975 (322, 322); 3 - P. Patrick and Eglinton is., 1974 (82, 63); 4 - Axel Heiberg I., 1974 (88, 59); 5 - P. Patrick I., 1948-52 (28, 28); 6 - Ellef Ringnes, Ellesmere is. (11, 4); 7 - Banks I., N.W. Mackenzie (29, 31); 8 - Foxe Basin (12, 23); 9 - Spitsbergen (61, 61); 10 - Alaska (32, 36); 11 - Greenland (15, 45).

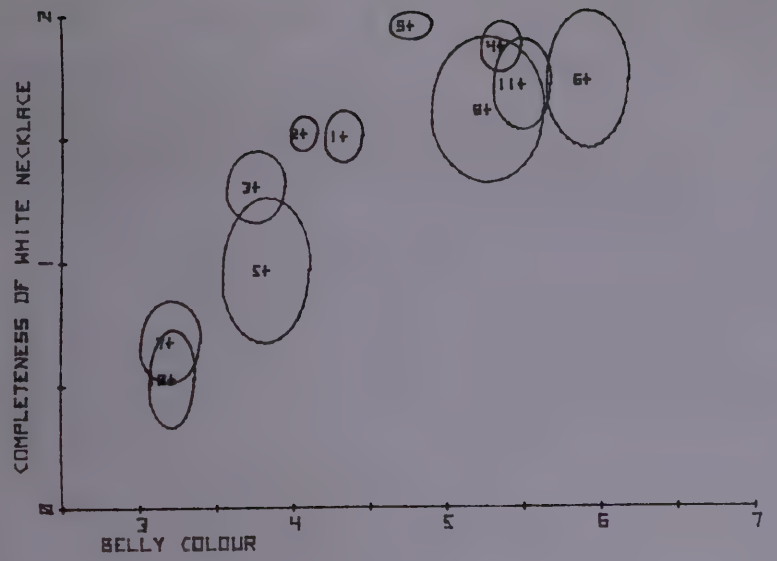

Figure 3.

Mean belly colour values of samples of brant drawn from different parts of the breeding range related to sample means of completeness of necklace. For key to numbers identifying locations of samples see caption to Figure 2.

Management Implications

It seems clear that the Parry Islands form a cockpit in which the absolute and relative abundance of 3 and perhaps 4 groups of brant fluctuates rapidly, and where the several forms have been occurring for at least 70 years. We suggest that this volatile situation justifies special protection being afforded to the meagre amounts of brant habitat that exist, so as to give the geese the best possible opportunity to continue this natural experiment. If the "Parry Islands brant" is to persist in the face of competition from Irish-wintering geese, which may well be increasing on Melville Island, and from irregular influxes of moult-migrants from further west, it would also be prudent to afford additional protection in Puget Sound, both to the geese themselves and to the limited sites they use.

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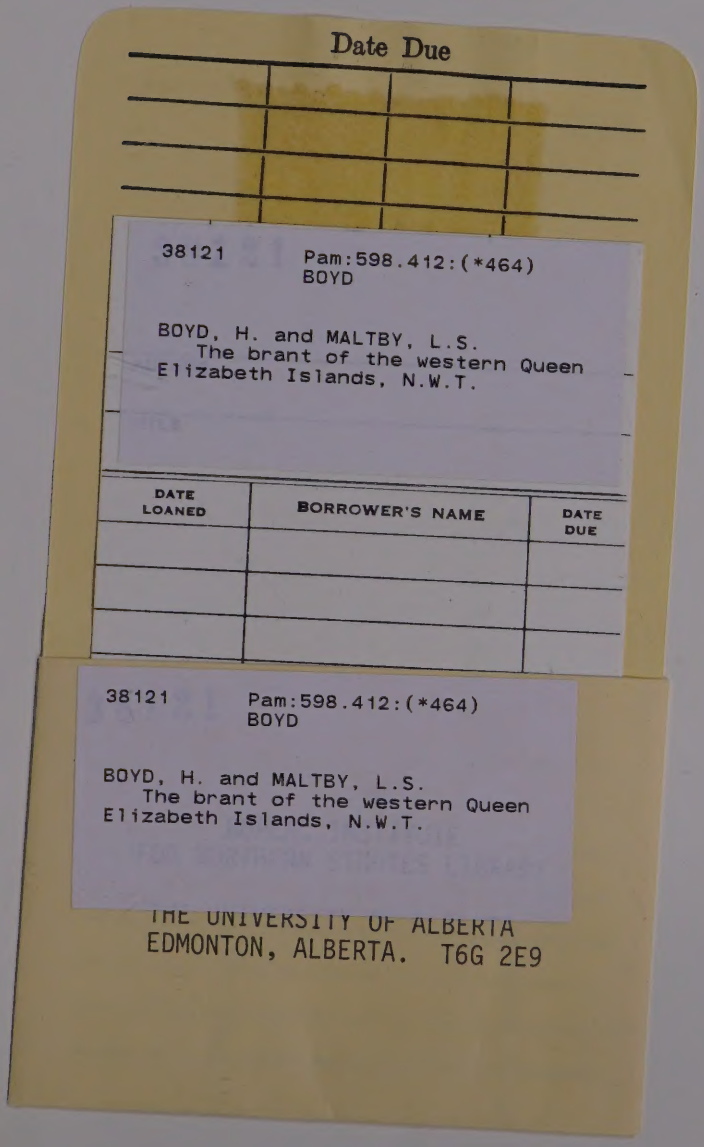

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